PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2004-154647
(43)Date of publication of application : 03.06.2004

(51)Int.Cl. B01D 39/20
B01D 46/00
F01N 3/02

(21)Application number : 2002-321306
(22)Date of filing : 05.11.2002

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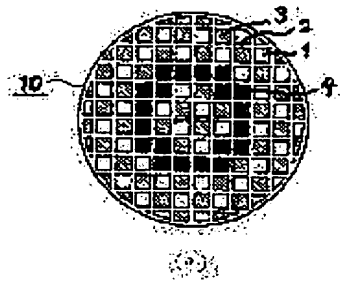
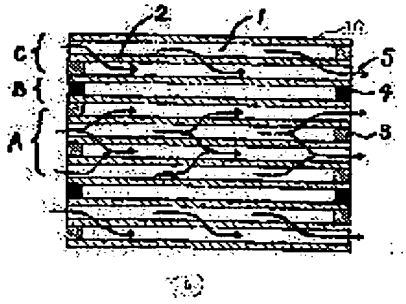
(54) CERAMICS HONEYCOMB FILTER

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a ceramics honeycomb filter made unnecessary to especially provide one or more joined places for relieving thermal distortion, less prone to damage at the time of burning regeneration of trapped PM and enhanced in heat resistance, impact resistance, durability and productivity.
SOLUTION: The ceramics honeycomb filter has a large number of almost parallel through-holes demarcated by porous partition walls so that the end surfaces of the filter are sealed checkwise fundamentally so as to close only the single ends of the through-holes. The through-holes are partially sealed at both ends.





LEGAL STATUS

[Date of request for examination] 20.09.2005

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1]
It is the ceramic honeycomb filter which is a ceramic honeycomb filter which was divided by the porous septum, and with which the ends side of a gas inlet and a gas outlet is closed in the shape of a checker so that it may have two or more in general parallel breakthroughs and only one end of this breakthrough may be blockaded fundamentally, and is characterized by closing the ends about said a part of breakthrough.
[Claim 2]
The ceramic honeycomb filter according to claim 1 with which the breakthrough by which said ends were closed is arranged in the shape of a periphery.
[Claim 3]
The breakthrough by which said ends were closed is the shape of a periphery, and the ceramic honeycomb filter according to claim 2 arranged continuously.
[Claim 4]
The ceramic honeycomb filter according to claim 2 or 3 whose shape of said periphery has the shape of an approximate circle configuration, an abbreviation elliptical, or an abbreviation square.
[Claim 5]
The ceramic honeycomb filter according to claim 4 which the shape of said periphery is an approximate circle configuration, and is in 0.2r-0.6r from the core of this inscribed circle when setting to r the radius of the circle with which the location is inscribed in the cross section of said end face.
[Claim 6]
The ceramic honeycomb filter according to claim 5 which has 70% or more of the breakthrough by which said ends are closed in 0.2r-0.6r from the core of said inscribed circle.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]
This invention is the ceramic porous body excellent in thermal resistance and thermal shock resistance, is suitable as a filter which carries out uptake of the particulate matter, such as soot discharged by internal combustion engines, such as a diesel power plant, and relates to the ceramic honeycomb filter which is hard to damage in case combustion playback of said particulate matter by which especially uptake was carried out is carried out.
[0002]
[Description of the Prior Art]
The diesel internal combustion engine or the lean combustion gasoline internal combustion engine contains the particulate matter (it abbreviates to PM hereafter) which uses as a principal component the soot called particulate MATA into the exhaust gas, and a ceramic honeycomb filter is used as an effective means which prevents bleedoff to the atmospheric air. Although PM for which dust was collected with the filter carries out oxidation combustion and is discharged as CO2 by raising engine exhaust gas temperature periodically, thermal stress occurs at the time of this combustion, and it may damage a filter.
[0003]
Moreover, fuel injection (postinjection) is used from combustion of PM which carried out uptake by the engine in many cases, when the amount of marginal PM of a filter is small, postinjection is frequently needed and an adverse effect is in fuel consumption. Furthermore, since a filter does not reach temperature required for combustion of PM even if it carries out fuel injection at the time of delay, when it runs in the state of delay for a long time, the amount of marginal PM is exceeded, and there is also a possibility that combustion may start at once and breakage of a filter may take place at the time of subsequent transit.
[0004]
Although the cordierite which is a low thermal expansion ingredient was used from a viewpoint which reduces thermal shock resistance as a cure against breakage resulting from combustion of the aforementioned PM, when the amount of PM heat-resistant temperature carried out [the amount] uptake to about 1300 degrees C low deposited and burned across the limitation, there was a problem that an erosion tends to happen by the generation of heat. Although SiC which is excellent in heat-resistant temperature and corrosion resistance as an ingredient which replaces cordierite, and Si3N4 are also considered, since coefficient of thermal expansion is larger than cordierite, improvement in thermal shock resistance is desired.
[0005]
The structure which combined the smaller honeycomb is proposed as a cure, without really fabricating a SiC filter (for example, patent reference 1 reference.). With this structure, since the thermal strain generated at the time of PM combustion is eased by the junctional zone of low Young's modulus, breakage is avoided, and it is supposed that the uptake of more amounts of PM can be carried out. However, since a large number [a junction part], there is a possibility that manufacture manday may increase.
[0006]
Moreover, as a honeycomb filter which does not do heat damage during combustion playback as another cure, a honeycomb filter is divided into a central field and a boundary region, the capacity which enlarges ventilation resistance of a central field and is passed is stopped, the particle alimentation of a central field is reduced, and the increase and the approach of carrying out and increasing the particle alimentation of a boundary region are proposed in the capacity which makes ventilation resistance of a boundary region small

and is passed conversely (for example, the patent reference 2, 3 reference.). Specifically in the central field, the closure pattern which closes more than 4 cels (henceforth a breakthrough) as one unit, and closes one cel as one unit conversely in a boundary region is proposed. However, there is a possibility that a closure activity may become complicated and productivity may become low also by this approach.
[0007]
[Patent reference 1]
JP,8-28248,A (1st page - the 5th page, drawing 2)
[Patent reference 2]
JP,4-148013,A (1st page - the 5th page, drawing 1, drawing 13)
[Patent reference 3]
JP,5-168834,A (1st page - the 5th page, drawing 2)
[0008]
[Problem(s) to be Solved by the Invention]
two or more junction parts for this invention to ease a thermal strain -- special ****** -- there are nothings, and it excels in the thermal resistance and thermal shock resistance which are hard to damage at the time of the combustion playback of PM by which uptake was carried out, and endurance, and, moreover, aims at offer of a ceramic honeycomb filter with high productivity, and its manufacturing method.
[0009]
[Means for Solving the Problem]
This invention offers the ceramic honeycomb filter which is a ceramic honeycomb filter which was divided by the porous septum, and with which the ends side of a gas inlet and a gas outlet is closed in the shape of a checker so that it may have two or more in general parallel breakthroughs and only one end of this breakthrough may be blockaded fundamentally, and is characterized by closing the ends about said a part of breakthrough.
[0010]
[Embodiment of the Invention]
This invention is based on the knowledge which observed and analyzed the gas flow in the conventional ceramic honeycomb filter (it only abbreviates to a honeycomb filter hereafter). The conventional honeycomb filter has two or more in general parallel breakthroughs divided by the porous septum, and means the filter with which the ends side of a gas inlet and a gas outlet is closed in the shape of a checker so that only one end of this breakthrough may be blockaded. When the outlet side is closed when it says closing the square or triangle of white and black in this description to the squares pattern which put the breakthrough of an ends side in order alternately as closing in the shape of a checker, its attention is paid to one breakthrough and the entrance side of the breakthrough is opened, and the entrance side is closed by reverse, it says opening an outlet side. Usually, in the case of a square, in the case of a square and a triangle, there are many things of an equilateral triangle.
[0011]
Drawing 2 explains the structure of the typical conventional honeycomb filter 20. (a) Drawing shows end view and (b) drawing shows drawing of longitudinal section of a flow direction, respectively. the inside of drawing, and 11 -- a breakthrough -- in 12, 13 shows a sealing agent and 15 shows gas flow for a porous septum, respectively.
Processed gas enters from the breakthrough 1 without a sealing agent 13, and comes out of the breakthrough 1 which passes the porous septum 2 and adjoins. A particle to carry out dust removing by the septum 2 of this porosity is caught.
[0012]
In drawing 2 , the gas flow 15 is illustrated so that it may become homogeneity, without being related to a location, but if it is observed and analyzed actually, it is not so. That is, the gas flow in the cross section parallel to an end face within the conventional honeycomb filter was not uniform, and knowledge that there being also many amounts of PM which the gas flow of the center of filter section is quick, and carry out uptake by the gas which flows in from a periphery in a core, and possibility of also generating in a core the breakage which combustion of PM is also performed in a core and is generated by the combustion are high was acquired further.
[0013]
This invention offers the honeycomb filter controlled not to concentrate the gas flow inside a filter on a center section, when ends originally close a part of breakthrough which closes only one end based on the above-mentioned knowledge. Although the ventilation resistance of the central whole field is raised by said

patent reference 2 and the patent reference 3 and it is made not to centralize gas flow on a center section, this invention establishes a field without gas flow in the boundary of a central field and a boundary region, and prevents a gas inflow to a central field from a boundary region.

[0014]

That is, the honeycomb filter (henceforth this filter) of this invention is a honeycomb filter which was divided by the porous septum and with which the ends side of a gas inlet and a gas outlet is closed in the shape of a checker so that it may have two or more in general parallel breakthroughs and only one end of said breakthrough may be blockaded fundamentally, and is characterized by closing the ends of some breakthroughs among said breakthroughs. In addition, although said the greater part of breakthrough closes only one end as only one end is fundamentally blockaded for said breakthrough, it is the semantics that a part is not so. The breakthrough (it only abbreviates to an ends closure breakthrough hereafter) which had ends closed serves as a field without gas flow, and intercepts substantially the flow of the gas between the central field inside it, and the boundary region outside it. The inflow of the heat to a central field can also be prevented by intercepting gas flow.

[0015]

Drawing 1 explains the structure of this filter. Drawing 1 is the schematic diagram of this filter 10 which has a circular cross section in a flow direction. (a) Drawing shows end view and (b) drawing shows drawing of longitudinal section of a flow direction, respectively. the inside of drawing 1 , and 1 -- a breakthrough -- 2 -- a porous septum -- in 3, 4 shows the sealing agent of an ends closure breakthrough, and 5 shows the flow direction of gas for a sealing agent, respectively. (b) Since an ends closure breakthrough is the field B without gas flow as it turns out that the gas flow 5 of drawing is seen, there is no flow of gas between the central field A inside it, and the boundary region C outside it.

[0016]

In addition, in this description, there is neither a gas inflow to this breakthrough nor the effluence of gas from this breakthrough closing ends, and the breakthrough concerned should just be substantially blockaded to gas. Although the approach of closing only the both ends of the breakthrough concerned as an example as shown in (b) drawing of drawing 1 is mentioned, it is not limited to it but the whole interior of the breakthrough concerned may be closed. When closing the whole interior of the breakthrough concerned, the heat capacity of the breakthrough concerned can be enlarged and the effectiveness which eases the temperature rise at the time of rapid combustion of PM in addition to the effectiveness which prevents a gas inflow to a central field from a boundary region can also be expected.

[0017]

In addition, if only both ends are closed without closing the whole interior of the breakthrough concerned and the space between the closure section is filled up with a heat-resistant particle like a silicon carbide particle, the effectiveness which eases said temperature rise can also be expected, rigid lifting is suppressed compared with the case where the whole breakthrough concerned is moreover closed, and it is desirable in respect of crack-proof nature. Although it may be filled up with a heat-resistant particle about all of ends closure breakthroughs when filled up with a heat-resistant particle, a part of ends closure breakthrough may be filled up with a heat-resistant particle.

[0018]

In this filter, although arrangement of an ends closure breakthrough is suitably chosen by the direction runoff distribution of the cross section of the gas which flows into the configuration of a honeycomb filter, or a honeycomb filter etc., it is desirable to arrange in the shape of a periphery within an end face. Creation is easy in the shape of said periphery having the shape of an approximate circle configuration, an abbreviation elliptical, or an abbreviation square, and it is desirable from a thing effective moreover. An approximate circle configuration means that it is a circle configuration on visual level here. The same is said of the shape of an abbreviation elliptical and an abbreviation square.

[0019]

In this filter, although it is desirable since the gas flow between said central fields and said boundary regions can be effectively intercepted if an ends closure breakthrough is arranged in the shape of a periphery within an end face and it is made to continue further, you may arrange discontinuously in the shape of a periphery within limits made into the object. The example continuously arranged by the shape of a periphery is (a) drawing of drawing 1 . The example nonsequetially arranged by the shape of a periphery is shown in drawing 3 . Drawing 3 is the schematic diagram of this filter 30 which has the same configuration except arrangement of drawing 1 and an ends closure breakthrough. 21 show the breakthrough by which only one end was closed in practice in the breakthrough although it was the location where 22 should become an ends

closure breakthrough about a porous septum when 24 arranges the sealing agent of an ends closure breakthrough and, as for 23, 26 arranges an ends closure breakthrough for a sealing agent continuously among drawing 3 , respectively.

[0020]

In this filter, the location of an ends closure breakthrough is also important. Although this location takes into consideration conditions, such as description of the processed gas passed in this filter, and the rate of flow, and the optimal location is chosen, even if too close [qualitatively / to a core] and it separates from a core too much again, since desired effectiveness is hard to be acquired, it is not desirable. In addition, when the location of the shape of said periphery is pinpointed, it shall take so that the number of ends closure breakthroughs may increase most.

[0021]

When the ends closure breakthrough has been arranged in the shape of a periphery in the approximate circle configuration within an end face and the radius of the circle inscribed in the cross section of a gas stream outlet is set to r, it is desirable to arrange in the shape of a periphery in the location of 0.2r-0.6r from the core of this inscribed circle. 0. If it arranges at the core rather than 2r, although the inflow of the gas to a core or heat can be checked, there is accumulation of heat out of the periphery, and the maximum temperature of the part is almost same with the core when not preparing an ends closure breakthrough. On the other hand, since the number of breakthroughs which will contribute to filtration of PM further preferably since there is concentration of the gas in a core or heat inside if the location of an ends closure breakthrough is made into a periphery side from 0.6r decreases and a pressure loss becomes high, it is not desirable. In addition, when the configuration of the end face of this filter is with a circle, r becomes the radius of the circle of this end face.

[0022]

In this filter, when the end face of a filter arranges an ends closure breakthrough in the shape of a periphery to an abbreviation elliptical with elliptical [of major-axis 2a and minor-axis 2b], it is 0.2a-0.6a and an ends closure breakthrough is arranged in the direction of a minor axis from this core in the direction of a major axis from the core of an end face at the location of 0.2b-0.6b, it is desirable. Moreover, it is desirable, when the end face of a filter arranges an ends closure breakthrough in the shape of a periphery in the shape of an abbreviation square by the shape of a square of vertical 2a and horizontal 2b, it is 0.2a-0.6a and an ends closure breakthrough is arranged from this core in a longitudinal direction from the core of an end face to a lengthwise direction at the location of 0.2b-0.6b.

[0023]

In this invention, among the total of an ends closure breakthrough, it is desirable that there is 70% or more in 0.2r-0.6r from the core of said inscribed circle, it is desirable in it being 80 more% or more, and is 90% or more more preferably. It is the most desirable when the total of an ends closure breakthrough is in 0.2r-0.6r from the core of an inscribed circle. r is set to b of minor-axis 2b of the ellipse of this cross section when the end face of this filter is an ellipse. When counting the total of an ends closure breakthrough, and the circle of imagination is lengthened to the end face of this filter, this thing shall count at a part of ends closure breakthrough. In the case of drawing 1 , it is the case where it is in 0.46r 20 total, and, in the case of drawing 3 , is the case where there is 14 piece =70% in 20 total in 0.46r.

[0024]

In this filter, the arrangement pattern of an ends closure breakthrough is not limited to drawing 1 and drawing 3 which were mentioned above, and the gas flow of a central field and a boundary region should just be divided substantially. The typical arrangement pattern of ends closure breakthroughs other than drawing 1 and drawing 3 is shown in drawing 4 . The breakthrough etc. is not illustrating among drawing. Drawing 4 (a) is a pattern with which the pattern over the perimeter is a duplex continuously. Drawing 4 (b) is the pattern which compounded the pattern nonsequetially arranged over the perimeter, and the pattern which quadrisects a periphery further.

[0025]

As an ingredient for closing an ends closure breakthrough in this filter, in it being the ingredient and this construction material of a honeycomb filter, since generating thermal stress is low, it is desirable. For example, when a honeycomb filter is Si3N4, also as for the ingredient for closing an ends closure breakthrough, it is desirable that it is Si3N4. The approach of closure is not restricted especially as long as gas is blockaded.

[0026]

Moreover, although it will not be restricted as construction material of this filter especially if it is the

ceramics, cordierite, Si3N4, SiC, etc. are mentioned. Moreover, as an application of this filter, although it is suitable as a filter for diesel particulate traps, it is not limited to especially this application.
[0027]
[Example]
This invention is explained based on an example below.
[0028]
Eight silicon nitride honeycomb filters (henceforth the filter for assessment) of one apparatus with a die length of 152mm which has the circular cross section whose outer-diameter dimension is the diameter of 144mm were prepared. The wall thickness of the porosity septum between 31 cels / cm2, and a breakthrough of the breakthrough (cel) consistency of the filter for assessment is 300 micrometers. All the filters for assessment were first closed in the shape of a checker.
[0029]
Among these, about seven of Example 1 - Example 7, an ends closure breakthrough is formed further, and especially the example 8 is considered as as [checkered], without forming an ends closure breakthrough. The distance from a core is changed in 8-55mm by the pattern which has arranged continuously Examples 1 other than example 4 - Example 7 in the shape of a periphery like drawing 1 . Example 7 filled up building envelopes other than the closure section of an ends closure breakthrough with the nitriding cay elementary particle (the product made from DENKA, trade name:SN-BL) with a mean particle diameter of 10 micrometers in Example 3. Example 4 is comparatively made nonsequential for 7 minutes so that it may become equal like drawing 3 omitting an ends closure breakthrough the shape of a periphery.
[0030]
Next, in order to check the effectiveness of an ends closure breakthrough, the filter for assessment of Example 1 - Example 8 was set to the diesel-power-plant trial bench, after depositing 20g PM, by postinjection, engine exhaust gas temperature was raised and PM was burned. Two or more thermocouples were inserted in the filter for assessment from the gas outlet side, and the maximum temperature gradient was searched for from the temperature data which measured and measured internal temperature at the time of a maximum temperature and combustion at the time of combustion. Time amount of postinjection was set as for 10 minutes. Ejection and the visual inspection according the existence of a crack to viewing estimated the filter for assessment after that. Moreover, the pressure loss before and behind postinjection (henceforth a pressure loss) was also measured, and it converted into the pressure loss in 400m3/h. A result is shown in a table 1.
[0031]
[A table 1]

	r ／mm	ハニカム半径との比	圧損 ／kPa	燃焼時最高温度／℃	燃焼時最大温度勾配／ ℃／cm	クラックの有無
例1	8	0．11	25．5	1100	200	疑わしいもの有
例2	15	0．21	26．5	1040	160	無
例3	20	0．28	27．7	1020	135	無
例4	20	0．28	27．0	1035	130	無
例5	40	0．56	28．0	1055	150	無
例6	55	0．76	29．5	1085	210	疑わしいもの有
例7	20	0．28	27．0	1000	115	無
例8	－	－	25．0	1120	210	多数有

[0032]
[Effect of the Invention]
With this filter, since the structure which establishes a field without gas flow in the boundary of a central

field and a boundary region, and prevents a gas inflow to a central field from a boundary region is adopted, a maximum temperature is reduced at the time of the maximum temperature gradient at the time of combustion playback of PM, and combustion, and it is hard to damage. Moreover, a means to prepare a field without gas flow also only closes the ends of the cel of a specific location, it is simple, and productivity is also high. If the ends of a specific breakthrough are closed as structure which prevents a gas inflow and the building envelope between the closure sections of this breakthrough is filled up with a heat-resistant particle, the effectiveness which eases the temperature rise at the time of rapid combustion of PM is also expectable. Therefore, by this invention, it is hard to damage at the time of combustion playback, and excels in thermal resistance, thermal shock resistance, and endurance, and, moreover, a honeycomb filter with high productivity can be offered.

[Brief Description of the Drawings]

[Drawing 1] The schematic diagram of this filter. (a) Circular sectional view. (b) Flow direction drawing of longitudinal section.

[Drawing 2] The schematic diagram of the common honeycomb filter 10 closed in the shape of a checker. (a) Circular sectional view. (b) Flow direction drawing of longitudinal section.

[Drawing 3] End view of this filter which closed ends intermittently in the shape of a periphery.

[Drawing 4] Drawing 1 of this filter, the example of a pattern of circular sectional views other than drawing 3 .

(a) The pattern with which the pattern over the perimeter is a duplex continuously. (b) The pattern which compounded the pattern nonsequetially arranged over the perimeter, and the pattern which quadrisects a periphery further.

[Description of Notations]

10 30: This filter.

20: The honeycomb filter closed in the shape of [conventional] a checker.

1, 11, 21: The breakthrough by which only one end was closed.

2, 12, 22: A porous septum.

3, 13, 23: The sealing agent for closing one end

4 24: The sealing agent for closing ends.

5 15: Gas flow.

26: The breakthrough by which only one end was closed in practice although it was the location which should serve as an ends closure breakthrough when arranging an ends closure breakthrough continuously.

A: A central field.

B: A field, an ends closure breakthrough without gas flow.

C: Boundary region.

r: The radius of the circle inscribed in the cross section of a gas stream outlet.

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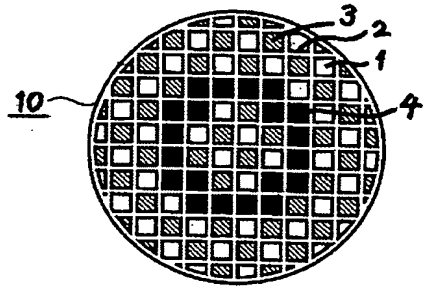
DRAWINGS

[Drawing 1]



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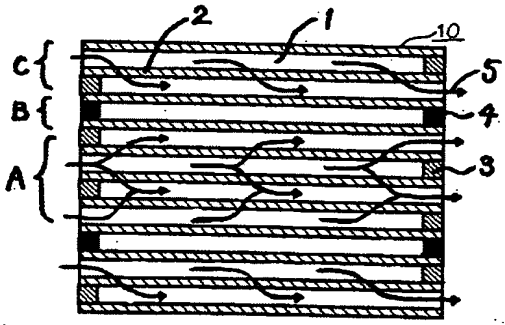
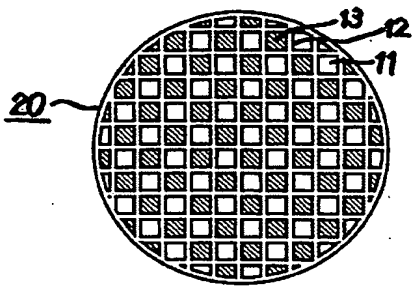


(b)

[Drawing 2]



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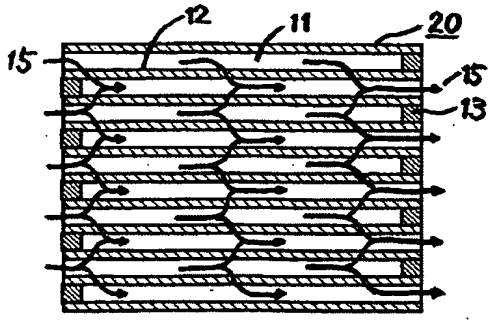
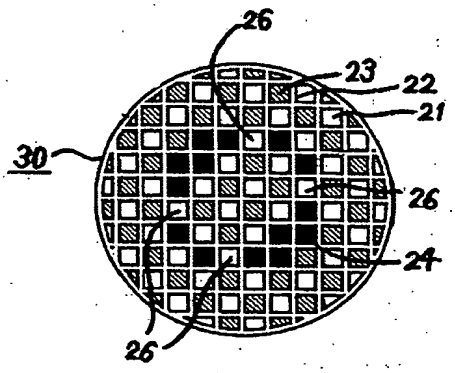
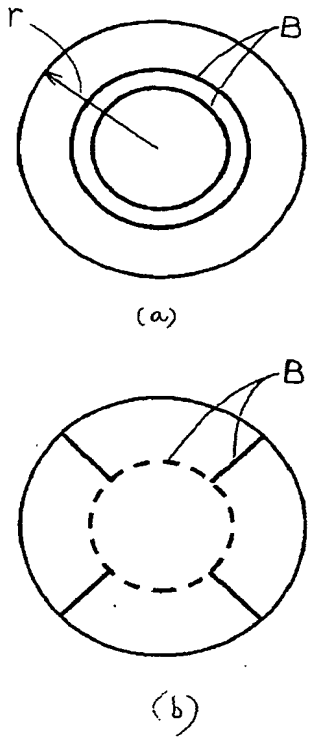


(b)

[Drawing 3]



[Drawing 4]



[Translation done.]

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2004-154647
(P2004-154647A)
(43)公開日　平成16年6月3日(2004.6.3)

(51)Int.Cl.[7]	F I			テーマコード（参考）
B01D 39/20	B01D	39/20	D	3G090
B01D 46/00	B01D	46/00	302	4D019
F01N 3/02	F01N	3/02	301C	4D058

審査請求 未請求　請求項の数 6　OL　（全 8 頁）

(21)出願番号　特願2002-321306(P2002-321306)
(22)出願日　平成14年11月5日(2002.11.5)

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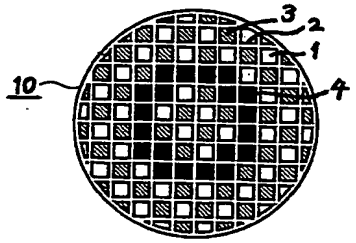
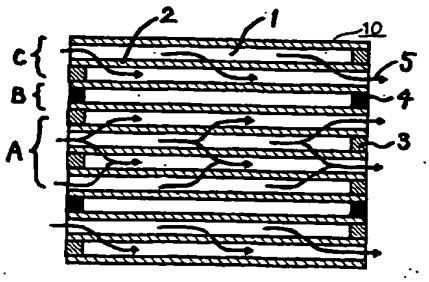
Fターム(参考)　3G090 AA02
4D019 AA01 BA05 BC12 BD10 CA01 CA03 CB04 CB06
4D058 JA37 JA38 JA39 JB06 SA08

(54)【発明の名称】セラミックスハニカムフィルタ

(57)【要約】
【課題】本発明は、熱歪を緩和するための複数の接合箇所を特段設けることなく、捕集されたＰＭの燃焼再生時に破損しにくい、耐熱性、耐衝撃性、耐久性に優れ、しかも生産性の高いセラミックスハニカムフィルタおよびその製造法の提供を目的とする。
【解決手段】多孔質の隔壁で区画された、複数のおおむね平行な貫通孔を有し、基本的に該貫通孔の片端のみが閉塞されるように、端面が市松模様状に封止されているセラミックスハニカムフィルタであって、前記貫通孔の一部についてはその両端が封止されていることを特徴とするセラミックスハニカムフィルタ。
【選択図】図１



(a)



(b)

【特許請求の範囲】
【請求項１】
多孔質の隔壁で区画された、複数のおおむね平行な貫通孔を有し、基本的に該貫通孔の片端のみが閉塞されるように、ガス入口とガス出口の両端面が市松模様状に封止されているセラミックスハニカムフィルタであって、前記貫通孔の一部についてはその両端が封止されていることを特徴とするセラミックスハニカムフィルタ。
【請求項２】
前記両端が封止された貫通孔が周状に配置されている請求項１記載のセラミックスハニカムフィルタ。
【請求項３】
前記両端が封止された貫通孔が周状、かつ連続的に配置されている請求項２記載のセラミックスハニカムフィルタ。
【請求項４】
前記周状が略円形状、略楕円形状または略四角形状である請求項２または３記載のセラミックスハニカムフィルタ。
【請求項５】
前記周状が略円形状であり、その位置が前記端面の断面に内接する円の半径をｒとするとき該内接円の中心から０．２ｒ～０．６ｒにある請求項４記載のセラミックスハニカムフィルタ。
【請求項６】
前記両端が封止されている貫通孔の内、７０％以上が前記内接円の中心から０．２ｒ～０．６ｒにある請求項５記載のセラミックスハニカムフィルタ。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】
本発明は、耐熱性、耐熱衝撃性に優れたセラミックス多孔体で、ディーゼルエンジンなどの内燃機関から排出されるスス等の粒子状物質を捕集するフィルタとして好適で、特に捕集された前記粒子状物質を燃焼再生する際に破損しにくい、セラミックスハニカムフィルタに関する。
【０００２】
【従来の技術】
ディーゼル内燃機関または希薄燃焼ガソリン内燃機関などは、その排気ガス中にパティキュレートマターと呼ばれるススを主成分とする粒子状物質（以下、ＰＭと略す）を含んでおり、その大気への放出を防ぐ有効な手段としてセラミックスハニカムフィルタが使用される。フィルタにより集塵されたＰＭは、定期的にエンジン排気ガス温度を上げることにより酸化燃焼させ、CO_2として排出されるが、この燃焼時に熱応力が発生し、フィルタを破損させることがある。
【０００３】
また、捕集したＰＭの燃焼にはエンジンにて燃料噴射（ポストインジェクション）が使われることが多く、フィルタの限界ＰＭ量が小さいと頻繁にポストインジェクションが必要となって燃費に悪影響がある。さらに、渋滞時には燃料噴射してもフィルタがＰＭの燃焼に必要な温度に達しないことから、長時間、渋滞状態で走行した場合には限界ＰＭ量を超えてしまい、その後の走行時に一度に燃焼が始まりフィルタの破損が起こるおそれもある。
【０００４】
前記のＰＭの燃焼に起因する破損対策として耐熱衝撃性を低減する観点から低熱膨張材料であるコーディエライトが使用されているが、耐熱温度が約１３００℃と低く捕集したＰＭ量が限界を超えて堆積し燃焼するとその発熱により溶損が起こりやすいという問題があった。コーディエライトに代わる材料として耐熱温度、耐食性に優れるＳｉＣやSi_3N_4も考えられるが熱膨張率がコーディエライトより大きいため耐熱衝撃性の向上が望まれ

ている。
【０００５】
対策として、ＳｉＣフィルタを一体成形せずに、より小さいハニカムを組み合わせた構造が提案されている（例えば、特許文献１参照。）。この構造ではＰＭ燃焼時に発生する熱歪が低ヤング率の接合層で緩和されることから破損が回避され、より多くのＰＭ量を捕集できるとされている。しかし、接合箇所が多数あるため、製造工数が多くなるおそれがある。
【０００６】
また、別の対策としては、燃焼再生中に熱損傷を与えないハニカムフィルタとして、ハニカムフィルタを中心領域と周辺領域に分け、中心領域の通気抵抗を大きくして通過するガス量を抑えて中心領域の微粒子堆積量を減らし、逆に周辺領域の通気抵抗を小さくして通過するガス量を増やし周辺領域の微粒子堆積量を増やす方法が提案されている（例えば、特許文献２、３参照。）。具体的には、中心領域では４セル（以下、貫通孔ともいう）以上を１つの単位として封止し、逆に周辺領域では１セルを１つの単位として封止する封止パターンが提案されている。しかし、この方法でも封止作業が複雑になり生産性が低くなるおそれがある。
【０００７】
【特許文献１】
特開平８－２８２４８号公報（第１頁～第５頁、第２図）
【特許文献２】
特開平４－１４８０１３号公報（第１頁～第５頁、第１図、第１３図）
【特許文献３】
特開平５－１６８８３４号公報（第１頁～第５頁、第２図）
【０００８】
【発明が解決しようとする課題】
本発明は、熱歪を緩和するための複数の接合箇所を特段設けることなく、捕集されたＰＭの燃焼再生時に破損しにくい、耐熱性、耐熱衝撃性、耐久性に優れ、しかも生産性の高いセラミックスハニカムフィルタおよびその製造法の提供を目的とする。
【０００９】
【課題を解決するための手段】
本発明は、多孔質の隔壁で区画された、複数のおおむね平行な貫通孔を有し、基本的に該貫通孔の片端のみが閉塞されるように、ガス入口とガス出口の両端面が市松模様状に封止されているセラミックスハニカムフィルタであって、前記貫通孔の一部についてはその両端が封止されていることを特徴とするセラミックスハニカムフィルタを提供する。
【００１０】
【発明の実施の形態】
本発明は、従来のセラミックスハニカムフィルタ（以下、単にハニカムフィルタと略す）内のガス流れを観察・解析した知見に基づく。従来のハニカムフィルタとは、多孔質の隔壁で区画された、複数のおおむね平行な貫通孔を有し、該貫通孔の片端のみが閉塞されるようにガス入口とガス出口の両端面が市松模様状に封止されているフィルタをいう。本明細書において、市松模様状に封止するとは、両端面の貫通孔を白と黒の四角形または三角形を互い違いに並べた碁盤目模様に封止することをいい、１つの貫通孔に着目したとき、その貫通孔の入口側が開放されているときはその出口側を封止し、逆に入口側が封止されているときは出口側を開放するようにすることをいう。通常、四角形の場合は正方形、三角形の場合は正三角形のことが多い。
【００１１】
図２で代表的な従来のハニカムフィルタ２０の構造を説明する。（ａ）図は端面図を、（ｂ）図は流れ方向の縦断面図をそれぞれ示す。図中、１１は貫通孔を、１２は多孔質の隔壁を、１３は封止材を、１５はガス流れを、それぞれ示す。
被処理ガスは封止材１３のない貫通孔１から入り多孔質の隔壁２を通過して隣接する貫通

孔１から出る。この多孔質の隔壁２で除塵したい微粒子を捕捉するものである。

【００１２】

図２ではガス流れ１５は場所に関係せずに均一になるように図示してあるが、実際に観察・解析するとそうではない。すなわち、従来のハニカムフィルタ内では端面と平行な横断面でのガス流れが均一ではなく、周辺部から流れ込むガスによりフィルタ中心部のガス流れが速く、捕集するＰＭ量も中心部で多いこと、さらにはＰＭの燃焼も中心部で行われ、その燃焼により発生する破損も中心部で発生する可能性が高いとの知見が得られた。

【００１３】

本発明は、上記知見に基づき、本来、片端のみを封止する貫通孔の一部を両端共に封止することによりフィルタ内部でのガス流れを中央部に集中しないように制御したハニカムフィルタを提供する。前記特許文献２、特許文献３では中心領域全体の通気抵抗を上げてガス流れを中央部に集中させないようにするものであるが、本発明は中心領域と周辺領域との境界にガス流れのない領域を設けて周辺領域から中心領域へのガス流入を阻止するものである。

【００１４】

すなわち、本発明のハニカムフィルタ（以下、本フィルタという）は、多孔質の隔壁で区画された、複数のおおむね平行な貫通孔を有し、基本的に前記貫通孔の片端のみが閉塞されるようにガス入口とガス出口の両端面が市松模様状に封止されているハニカムフィルタであって、前記貫通孔のうち一部の貫通孔の両端を封止することを特徴とする。なお、基本的に前記貫通孔が片端のみが閉塞されるとは、前記貫通孔の大部分が片端のみを封止するが一部はそうではない、との意味である。両端を封止された貫通孔（以下、単に両端封止貫通孔と略す）がガス流れのない領域となり、それより内側の中心領域と、それより外側の周辺領域との間でのガスの流れを実質的に遮断する。ガス流れを遮断することにより、中心領域への熱の流入も防げる。

【００１５】

本フィルタの構造を図１により説明する。図１は、流れ方向に円形断面を有する本フィルタ１０の概略図である。（ａ）図は端面図を、（ｂ）図は流れ方向の縦断面図をそれぞれ示す。図１中、１は貫通孔を、２は多孔質の隔壁を、３は封止材を、４は両端封止貫通孔の封止材を、５はガスの流れ方向を、それぞれ示す。（ｂ）図のガス流れ５をみると分かるように、両端封止貫通孔がガス流れのない領域Ｂであるため、それより内側の中心領域Ａと、それより外側の周辺領域Ｃとの間にガスの流れはない。

【００１６】

なお、本明細書において、両端を封止するとは、該貫通孔へのガス流入や該貫通孔からのガス流出がなく、実質的にガスに対して当該貫通孔が閉塞されていればよい。一例として図１の（ｂ）図のように当該貫通孔の両端部だけを封止する方法が挙げられるが、それに限定されず、当該貫通孔の内部全体を封止してもよい。当該貫通孔の内部全体を封止する場合には、当該貫通孔の熱容量を大きくすることができ、周辺領域から中心領域へのガス流入を阻止する効果に加えてＰＭの急速燃焼時の温度上昇を緩和する効果も期待できる。

【００１７】

なお、当該貫通孔の内部全体を封止せずに両端部だけを封止し、その封止部の間の空間を炭化ケイ素粒子のような耐熱性粒子で充填すると前記温度上昇を緩和する効果も期待でき、しかも当該貫通孔全体を封止する場合に比べて剛性の上昇が抑えられ耐クラック性の点で好ましい。耐熱性粒子を充填する場合には両端封止貫通孔の全部について耐熱性粒子を充填してもよいが、両端封止貫通孔の一部に耐熱性粒子を充填してもよい。

【００１８】

本フィルタにおいて、両端封止貫通孔の配置は、ハニカムフィルタの形状やハニカムフィルタに流入するガスの横断面方向流出分布などにより適宜選択されるが、端面内で周状に配置するのが好ましい。前記周状が略円形状、略楕円形状または略四角形状であると作成が容易であり、しかも効果的であることから好ましい。ここで略円形状とは、目視レベルで円形状であることをいう。略楕円形状、略四角形状についても同様である。

【００１９】
本フィルタにおいて、両端封止貫通孔を端面内で周状に配置し、さらに連続するようにすると前記中心領域と前記周辺領域との間のガス流れを効果的に遮断できるため好ましいが、目的とする範囲内で周状に不連続に配置してもよい。周状で連続的に配置した例が図１の（ａ）図である。周状で不連続的に配置した例を図３に示す。図３は、図１と両端封止貫通孔の配置以外は同一構成を有する本フィルタ３０の概略図である。図３中、２１は貫通孔を、２２は多孔質の隔壁を、２３は封止材を、２４は両端封止貫通孔の封止材を、２６は両端封止貫通孔を連続的に配置する場合には両端封止貫通孔となるべき場所であるが、実際は、片端のみが封止された貫通孔を、それぞれ示す。

【００２０】
本フィルタにおいて、両端封止貫通孔の位置も重要である。該位置は本フィルタに流す被処理ガスの性状、流速、等の条件を勘案して最適な位置が選択されるが、定性的には中心に近すぎてもまた中心から離れすぎても所望の効果は得られにくいため好ましくない。なお、前記周状の位置を特定するときは、両端封止貫通孔の数が最も多くなるようにとるものとする。

【００２１】
両端封止貫通孔を端面内で略円形状に周状に配置する場合、ガス流出口の断面に内接する円の半径をｒとしたとき、該内接円の中心から０．２ｒ～０．６ｒの位置に周状に配置するのが好ましい。０．２ｒよりも中心に配置すると中心部へのガスや熱の流入は阻害できるものの、その外周外で熱の集積があり、その部分の最高温度は両端封止貫通孔を設けない場合の中心部とあまり差異がない。一方、両端封止貫通孔の位置を０．６ｒより外周側とすると、内側で中心部でのガスや熱の集中があるため好ましくなく、さらに、ＰＭのろ過に寄与する貫通孔数が減少し圧損が高くなるため好ましくない。なお、本フィルタの端面の形状が円でである場合は、ｒは該端面の円の半径となる。

【００２２】
本フィルダにおいて、フィルタの端面が長軸２ａ、短軸２ｂの楕円形状で両端封止貫通孔を略楕円形状に周状に配置する場合には、両端封止貫通孔を端面の中心から長軸方向に０．２ａ～０．６ａで、かつ該中心から短軸方向に０．２ｂ～０．６ｂの位置に配置すると好ましい。また、フィルタの端面が縦２ａ、横２ｂの四角形状で両端封止貫通孔を略四角形状に周状に配置する場合には、両端封止貫通孔を端面の中心から縦方向に０．２ａ～０．６ａで、かつ該中心から横方向に０．２ｂ～０．６ｂの位置に配置すると好ましい。

【００２３】
本発明において、両端封止貫通孔の全数中、７０％以上が前記内接円の中心から０．２ｒ～０．６ｒにあることが好ましく、さらには８０％以上であると好ましく、より好ましくは９０％以上である。両端封止貫通孔の全数が内接円の中心から０．２ｒ～０．６ｒにあると最も好ましい。本フィルタの端面が楕円である場合、ｒは該断面の楕円の短軸２ｂのｂとなる。両端封止貫通孔の全数をカウントする場合、本フィルタの端面に仮想の円を引いたときに両端封止貫通孔の一部でもかかるものはカウントするものとする。図１の場合は０．４６ｒに全数２０個ある場合であり、図３の場合は０．４６ｒに全数２０個中１４個＝７０％ある場合である。

【００２４】
本フィルタにおいて両端封止貫通孔の配置パターンは前述した図１、図３に限定されるものではなく、中心領域と周辺領域とのガス流れが実質的に分断されていればよい。図１、図３以外の両端封止貫通孔の代表的な配置パターンを図４に示す。図中、貫通孔等は図示していない。図４（ａ）は連続的に全周に渡るパターンが２重になっているパターンである。図４（ｂ）は不連続的に全周に渡って配置するパターンと周辺部をさらに４分割するパターンとを複合したパターンである。

【００２５】
本フィルタにおいて両端封止貫通孔を封止するための材料としては、ハニカムフィルタの材料と同材質であると発生熱応力が低いため好ましい。例えば、ハニカムフィルタがＳｉ

$_3N_4$であるときは、両端封止貫通孔を封止するための材料もSi_3N_4であることが好ましい。封止の方法は、ガスが閉塞される限り特に制限されるものでない。

【００２６】

また、本フィルタの材質としては、セラミックスであれば特に制限されないが、コーディエライト、Si_3N_4、ＳｉＣなどが挙げられる。また、本フィルタの用途としては、ディーゼルパティキュレートトラップ用フィルタとして好適なものであるが、特にこの用途に限定されるものではない。

【００２７】

【実施例】

以下に本発明を実施例に基づいて説明する。

【００２８】

外径寸法が直径１４４ｍｍの円形断面を有する長さ１５２ｍｍの一体型の窒化ケイ素ハニカムフィルタ（以下、評価用フィルタという）を８個準備した。評価用フィルタの貫通孔（セル）密度は３１セル／cm^2、貫通孔間の多孔質隔壁の壁厚は３００μｍである。まず全部の評価用フィルタを市松模様状に封止した。

【００２９】

このうち、例１～例７の７個については両端封止貫通孔をさらに形成し、例８は特に両端封止貫通孔を形成せずに市松模様状のままとしてある。例４以外の例１～例７は、図１と同様に円周状に連続的に配置したパターンで中心からの距離は８～５５ｍｍの範囲で変えてある。例７は例３において両端封止貫通孔の封止部以外の内部空間を平均粒子直径１０μｍの窒化ケイ素粒子（デンカ社製、商品名：ＳＮ－ＢＬ）で充填した。例４は図３と同様に円周状に両端封止貫通孔が略均等になるように不連続的に７分割としたものである。

【００３０】

次に両端封止貫通孔の効果を確認するため、例１～例８の評価用フィルタをディーゼルエンジン試験ベンチにセットして２０ｇのＰＭを堆積後、ポストインジェクションによってエンジン排気ガス温度を上昇させ、ＰＭの燃焼を行った。評価用フィルタにはガス出口側から複数の熱電対を挿入して内部温度を測定し、測定した温度データから燃焼時最高温度、燃焼時最大温度勾配を求めた。ポストインジェクションの時間は１０分間とした。その後評価用フィルタを取り出し、クラックの有無を目視による外観検査で評価した。またポストインジェクション前後の圧力損失（以下、圧損という）も測定し、４００m^3／ｈでの圧損に換算した。結果を表１に示す。

【００３１】

【表１】

	r／mm	ハニカム半径との比	圧損／kPa	燃焼時最高温度／℃	燃焼時最大温度勾配／℃／cm	クラックの有無
例1	8	0.11	25.5	1100	200	疑わしいもの有
例2	15	0.21	26.5	1040	160	無
例3	20	0.28	27.7	1020	135	無
例4	20	0.28	27.0	1035	130	無
例5	40	0.56	28.0	1055	150	無
例6	55	0.76	29.5	1085	210	疑わしいもの有
例7	20	0.28	27.0	1000	115	無
例8	－	－	25.0	1120	210	多数有

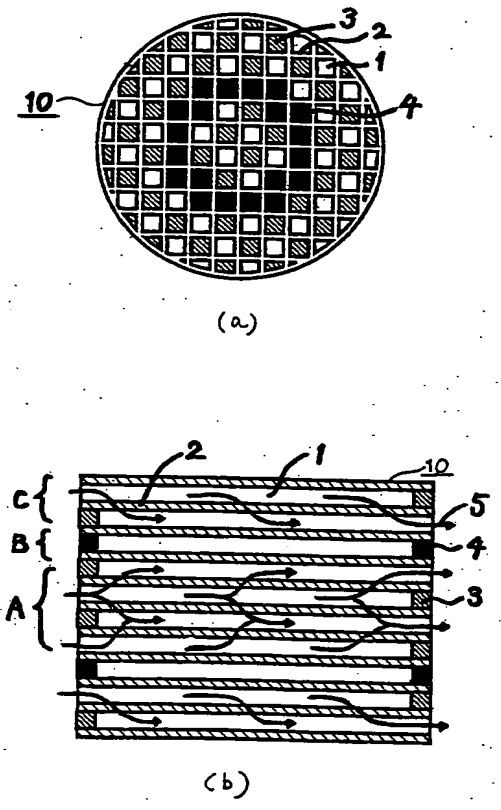
【００３２】

【発明の効果】
本フィルタでは、中心領域と周辺領域との境界にガス流れのない領域を設けて周辺領域から中心領域へのガス流入を阻止する構造を採用しているので、ＰＭの燃焼再生時の最大温度勾配、燃焼時最高温度を低減して破損しにくい。また、ガス流れのない領域を設ける手段も単に特定位置のセルの両端を封止するだけであり、簡易で生産性も高い。ガス流入を阻止する構造として特定の貫通孔の両端を封止し該貫通孔の封止部間の内部空間を耐熱性粒子で充填するとＰＭの急速燃焼時の温度上昇を緩和する効果も期待できる。したがって、本発明により、燃焼再生時に破損しにくく、耐熱性、耐熱衝撃性、耐久性に優れ、しかも生産性の高いハニカムフィルタを提供できる。

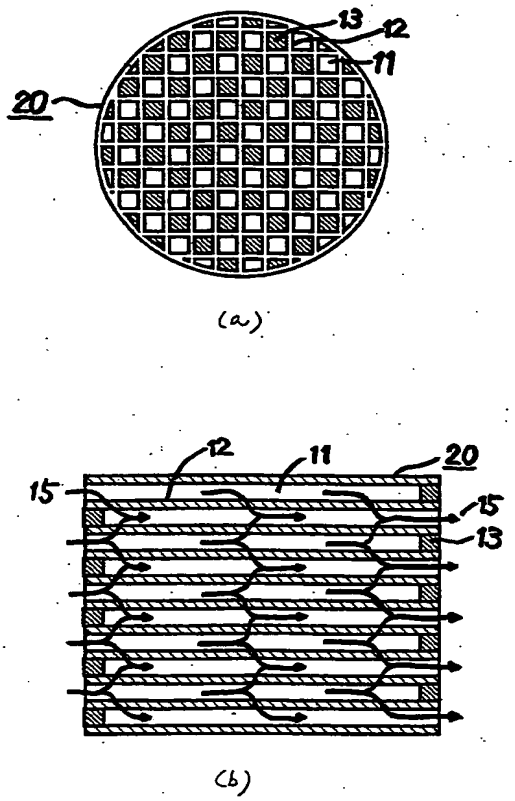
【図面の簡単な説明】
【図１】本フィルタの概略図。（ａ）円形断面図。（ｂ）流れ方向縦断面図。
【図２】市松模様状に封止された、一般的なハニカムフィルタ１０の概略図。（ａ）円形断面図。（ｂ）流れ方向縦断面図。
【図３】周状に断続的に両端を封止した本フィルタの端面図。
【図４】本フィルタの図１、図３以外の円形断面図のパターン例。
（ａ）連続的に全周に渡るパターンが２重になっているパターン。（ｂ）不連続的に全周に渡って配置するパターンと周辺部をさらに４分割するパターンとを複合したパターン。

【符号の説明】
１０、３０：本フィルタ。
２０：従来の市松模様状に封止されたハニカムフィルタ。
１、１１、２１：片端のみが封止された貫通孔。
２、１２、２２：多孔質の隔壁。
３、１３、２３：片端を封止するための封止材
４、２４：両端を封止するための封止材。
５、１５：ガス流れ。
２６：両端封止貫通孔を連続的に配置する場合には両端封止貫通孔となるべき場所であるが、実際は、片端のみが封止された貫通孔。
Ａ：中心領域。
Ｂ：ガス流れのない領域、両端封止貫通孔。
Ｃ：周辺領域。
ｒ：ガス流出口の断面に内接する円の半径。

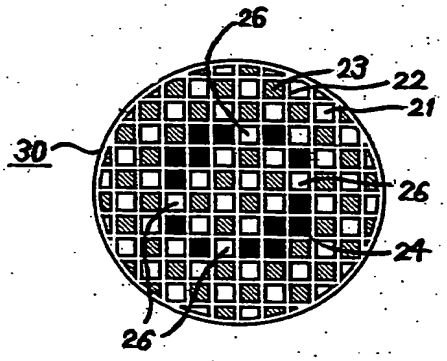
【図１】


3
2
1
10
4
(a)
2
1
10
C
B
A
5
4
3
(b)

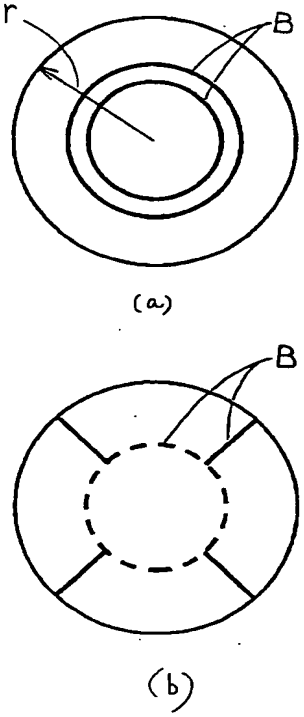
【図２】


13
12
11
20
(a)
12
11
20
15
15
13
(b)

【図３】


26
23
22
21
30
26
24
26

【図４】


r
B
(a)
B
(b)